CLAIMS

What is claimed is:

1. A processor implemented data processing method comprising:

identifying a first plurality of regions within a first recursively partitioned/nested geometric structure that correspond to a first plurality of normalized multi-dimensional data of a first normalized multi-dimensional data space, the first recursively partitioned/nested geometric structure being corresponding to the first normalized multi-dimensional data space;

determining corresponding first graphing values for said first corresponding regions within said first recursively partitioned/nested geometric structure determined for said first normalized multi-dimensional data of said first normalized multi-dimensional data space;

associating corresponding first visual attributes with said first corresponding regions within said first recursively partitioned/nested geometric structure, based at least in part on corresponding ones of said determined first graphing values; and

displaying said first recursively partitioned/nested geometric structure, visually differentiating said first corresponding regions based at least in part on corresponding ones of said associated first visual attributes.

2. The method of claim 1, wherein each of said first normalized multi-dimensional data of said first normalized multi-dimensional data space comprises a plurality of relative coordinate values, and the method further comprises constructing a polynary string to represent each of said first normalized multi-dimensional data and its corresponding one of said first regions within said first recursively

partitioned/nested geometric structure in accordance with the relative coordinate values.

3. The method of claim 2, wherein said constructing of a polynary string to represent each of said first normalized multi-dimensional data and its corresponding one of said first regions within said first recursively partitioned/nested geometric structure in accordance with the relative coordinate values comprises selecting a symbol as the next symbolic member of the polynary string based on which of the relative coordinate values is the current highest relative coordinate value.

4. The method of claim 3, wherein said constructing of a polynary string to represent each of said first normalized multi-dimensional data and its corresponding one of said first regions within said first recursively partitioned/nested geometric structure in accordance with the relative coordinate values further comprises reducing the highest relative coordinate value in by an amount (G), upon each selection, and reducing the amount (G) after each reduction.

5. The method of claim 4, wherein the amount (G) initially equals 1 – F, and thereafter reduced each time by G*(1 – F), where F equals (n – 1)/n, and n equals the number of relative coordinate values.

6. The method of claim 2, wherein said determining of corresponding first graphic values comprises determining frequencies of occurrence of the various polynary strings of said first normalized multi-dimensional data, and assigning the determined frequencies of occurrence to the corresponding first regions within the

first recursively partitioned/nested geometric structure as the determined first graphing values of the corresponding first regions.

7. The method of claim 1, wherein said determining of corresponding first graphic values comprises assigning first output values corresponding to the first normalized multi-dimensional data as the determined first graphing values of the corresponding first regions within the first recursively partitioned/nested geometric structure.

8. The method of claim 7, wherein said determining of corresponding first graphic values further comprises computing said first output values.

9. The method of claim 8, wherein each of said first normalized multi-dimensional data of said first normalized multi-dimensional data space comprises a polynary string having a plurality of symbols, encoding a plurality of relative coordinate values, and said computing of the first output values comprises

for each constituting symbols of a polynary string, summing one or more appearance values corresponding to one or more appearances of the particular symbol in the polynary string, and adding the sum to an average residual relative coordinate value.

10. The method of claim 9, wherein each appearance value corresponding to an appearance of a particular symbol is dependent on the position of the particular appearance of the particular symbol in the polynary string.

11. The method of claim 10, wherein each appearance value corresponding to an appearance of a particular symbol is equal to a positional value associated with the position of the particular appearance in the polynary string.

12. The method of claim 11, wherein

each positional value equals to (1 – F) x F**(k – 1), and

the average residual relative coordinate value equals (1 – F) x F**K,

where F equals (n – 1)/n,

k denotes a position in a polynary string,

n equals the number of relative coordinate values, and

K equals the length of the polynary string.

13. The method of claim 2, wherein the method further comprises

receiving a first zooming specification comprising one or more of said polynary string constituting symbols;

excluding a first subset of said first regions based at least in part on said received first zooming specification; and

repeating said displaying for the remaining ones of said first regions in an expanded manner.

14. The method of claim 13, wherein the method further comprises

receiving a second zooming specification comprising one or more additional ones of said polynary string constituting symbols;

excluding a second subset of said remaining ones of said first regions based at least in part on said received second zooming specification; and

repeating said displaying for the remaining ones of said first regions.

15. The method of claim 14, wherein the method further comprises

receiving an unzoom specification;

restoring the remaining ones of said first regions to re-include said excluded second subset of said first regions; and

repeating said displaying for the remaining ones of said first regions.

16. The method of claim 13, wherein the method further comprises

receiving an unzoom specification;

restoring the remaining ones of said first regions to re-include said excluded first subset of said first regions; and

repeating said displaying for said first regions.

17. The method of claim 1, wherein said associating comprises for each of said first regions, associating a selected one of a plurality of symbols with the region based at least in part on the determined graphing value of the region.

18. The method of claim 1, wherein said associating comprises for each of said first regions, associating a selected one of a plurality of color attributes with the region based at least in part on the determined graphing value of the region.

19. The method of claim 1, wherein said associating comprises for each of said first regions, associating a selected one of a plurality of colored geometric primitives with the region based at least in part on the determined graphing value of the region.

20. The method of claim 1, wherein said associating comprises for each of said first regions, associating a selected blending of a plurality of colors with the region based at least in part on contributions to the determined graphing value of the region.

21. The method of claim 1, wherein said first regions correspond to all constituting regions of the first recursively partitioned/nested geometric structure, said first normalized multi-dimensional data are values of independent variables of a function, and said first graphing values are corresponding values of a dependent variable of the function.

22. The method of claim 1, wherein the method further comprises

identifying a second plurality of regions within a second recursively partitioned/nested geometric structure that correspond to a second plurality of normalized multi-dimensional data of a second normalized multi-dimensional data space, the second recursively partitioned/nested geometric structure being corresponding to the second normalized multi-dimensional data space;

determining corresponding second graphing values for said second corresponding regions within said second recursively partitioned/nested geometric structure determined for said second normalized multi-dimensional data of said second normalized multi-dimensional data space;

associating corresponding second visual attributes with said second corresponding regions within said second recursively partitioned/nested geometric structure, based at least in part on corresponding ones of said determined second graphing values; and

displaying said second recursively partitioned/nested geometric structure, visually differentiating said second corresponding regions based at least in part on corresponding ones of said associated second visual attributes.

23. The method of claim 22, wherein said first and second recursively partitioned/nested geometric structures are displayed in a manner such that both recursively partitioned/nested geometric structures are visible concurrently.

24. The method of claim 23, wherein each of said first and second normalized multi-dimensional data of said first and second normalized multi-dimensional data spaces comprises a polynary string having a plurality of symbols, encoding a plurality of relative coordinate values, the method further comprises

receiving a first zooming specification comprising one or more of said polynary string constituting symbols;

excluding a first subset of said first regions based at least in part on said received first zooming specification;

excluding a second subset of said second regions based at least part on the removed ones of said first regions; and

repeating said displaying for the remaining ones of said first and second regions.

25. The method of claim 22, wherein said first and second normalized multi-dimensional data are values of first and second input variables.

26. The method of claim 22, wherein said first normalized multi-dimensional data are values of input variables, and said second normalized multi-dimensional data are values of corresponding output variables.

27. The method of claim 1, wherein the method further comprises computing a location for a centroid for each of a plurality primitive elements of the geometric structure.

28. The method of claim 27, wherein coordinates (x_p, y_p) of the location of each centroid is computed as follows:

$$Xp = Xc + R * \sum_{k=1}^{K} V(N,k) * C(N,m[Lk])$$

$$Yp = Yc + R * \sum_{k=1}^{K} V(N,k) * S(N,m[Lk])$$

where:

(X_c, Y_c) are coordinate values of the geometric structure's centroid;

R is a radius extending from the geometric structure's centroid to an outermost vertex of the geometric structure;

V(N, k) is w*(1 – w) **(k – 1) where w = 1/(1+sine(π/N));

m[L_k] is outer vertex number (1, 2, ..., N) assigned to the kth symbol appearing in a corresponding polynary string;

C(N, m[L_k]) = cosine(a* π); and

S(N, m[L_k]) = sine(a* π) [where a = (5*N – 4*m[L_k])/(2*N)].

29. The method of claim 28, wherein the K values of V(N, k) are computed once responsive to a specification of N.

30. The method of claim 28, wherein at least the N values of $C(N, m[L_k])$ or the N values of $S(N, m[L_k])$ are computed once responsive to a specification of N.

31. A processor implemented data processing method for generating a polynary string representation for an entity defined by n relative coordinate values, n being an integer, comprising:

associating n symbolic representations with said n relative coordinate values; and

selecting the symbolic representation corresponding to the highest relative coordinate value as the first constituting member of the polynary string representation.

32. The method of claim 31, wherein the method further comprises

computing a constant value (F) by dividing (n – 1) by n; and

computing a variable value (G) by subtracting F from 1;

subtracting G from the current highest relative coordinate value; and

selecting the symbolic representation corresponding to the current highest relative coordinate value as the next constituting member of the polynary string representation.

33. The method of claim 32, wherein the method further comprises

multiplying the current value of G by F;

subtracting G from the current highest relative coordinate value; and

selecting the symbolic representation corresponding to the current highest relative coordinate value as the next constituting member of the polynary string representation.

34. The method of claim 33, wherein the method further comprises repeating said multiply, subtracting and selecting operations set forth in claim 29.

35. The method of claim 31, wherein said symbolic representation comprises a letter.

36. The method of claim 31, wherein said symbolic representation comprises a special character.

37. A processor implemented data processing method for generating a relative coordinate value for an constituting variable of an entity, the entity being represented by a polynary string representation having a plurality of symbolic members representing the constituting variables, the method comprising:

determining appearance positions of appearance instances of the symbolic members in said polynary string representation;

summing positional values corresponding to the appearance instances of the symbolic members in said polynary string representation; and

adding the sum to an average residual relative coordinate value.

38. The method of claim 37, wherein

each positional value equals to $(1 - F) \times F^{**}(k - 1)$, and

the average residual relative coordinate value equals $(1 - F) \times F^{**}K$,

where F equals $(n - 1)/n$,

n equals the number of coordinate values,

k denotes a position in the polynary string representation; and

K equals the length of the polynary string.

39. An apparatus comprising:

storage medium having stored therein programming instructions designed to enable the apparatus to

identify a first plurality of regions within a first recursively partitioned/nested geometric structure that correspond to a first plurality of normalized multi-dimensional data of a first normalized multi-dimensional data space, the first recursively partitioned/nested geometric structure being corresponding to the first normalized multi-dimensional data space,

determine corresponding first graphing values for said first corresponding regions within said first recursively partitioned/nested geometric structure determined for said first normalized multi-dimensional data of said first normalized multi-dimensional data space;

associate corresponding first visual attributes with said first corresponding regions within said first recursively partitioned/nested geometric structure, based at least in part on corresponding ones of said determined first graphing values, and

display said first recursively partitioned/nested geometric structure, visually differentiating said first corresponding regions based at least in part on corresponding ones of said associated first visual attributes; and

at least one processor coupled to the storage medium to execute the programming instructions.

40. The apparatus of claim 39, wherein each of said first normalized multi-dimensional data of said first normalized multi-dimensional data space comprises a plurality of relative coordinate values, and the programming instructions are further designed to enable the apparatus to construct a polynary string to represent each of said first normalized multi-dimensional data and its corresponding one of said first regions within said first recursively partitioned/nested geometric structure in accordance with the relative coordinate values.

41. The apparatus of claim 40, wherein said programming instructions are designed to enable the apparatus to perform said constructing of a polynary string by selecting a symbol as the next symbolic member of the polynary string based on which of the relative coordinate values is the current highest relative coordinate value.

42. The apparatus of claim 41, wherein said programming instructions are further designed to enable the apparatus to perform said constructing of a polynary string by reducing the highest relative coordinate value in by an amount (G), upon each selection, and reducing the amount (G) after each reduction.

43. The apparatus of claim 42, wherein said programming instructions are designed to enable the apparatus to set the amount (G) initially to $1 - F$, and thereafter reduced each time by $G^*(1 - F)$, where F equals $(n - 1)/n$, and n equals the number of relative coordinate values.

44. The apparatus of claim 40, wherein said programming instructions are designed to enable the apparatus to perform said determining by determining

frequencies of occurrence of the various polynary strings of said first normalized multi-dimensional data, and assigning the determined frequencies of occurrence to the corresponding first regions within the first recursively partitioned/nested geometric structure as the determined first graphing values of the corresponding first regions.

45. The apparatus of claim 39, wherein said programming instructions are designed to enable the apparatus to perform said determining by assigning first output values corresponding to the first normalized multi-dimensional data as the determined first graphing values of the corresponding first regions within the first recursively partitioned/nested geometric structure.

46. The apparatus of claim 45, wherein said programming instructions are further designed to enable the apparatus to perform said determining by computing said first output values.

47. The apparatus of claim 46, wherein each of said first normalized multi-dimensional data of said first normalized multi-dimensional data space comprises a polynary string having a plurality of symbols, encoding a plurality of relative coordinate values, and said programming instructions are designed to enable the apparatus to perform said computing by

summing one or more appearance values corresponding to one or more appearances of the particular symbol in a polynary string, and adding the sum to an average residual relative coordinate value, and

repeating said summing and adding for each constituting symbols of the polynary string.

48. The apparatus of claim 47, wherein each appearance value corresponding to an appearance of a particular symbol is dependent on the position of the particular appearance of the particular symbol in the polynary string.

49. The apparatus of claim 48, wherein each appearance value corresponding to an appearance of a particular symbol is equal to a positional value associated with the position of the particular appearance in the polynary string.

50. The apparatus of claim 49, wherein

each positional value equals to $(1 - F) \times F{**}(k - 1)$, and

the average residual relative coordinate value equals $(1 - F) \times F{**}K$,

where F equals $(n - 1)/n$,

k denotes a position in a polynary string,

n equals the number of relative coordinate values, and

K equals the length of the polynary string.

51. The apparatus of claim 40, wherein said programming instructions are further designed to enable the apparatus to

receive a first zooming specification comprising one or more of said polynary string constituting symbols;

exclude a first subset of said first regions based at least in part on said received first zooming specification; and

repeat said displaying for the remaining ones of said first regions in an expanded manner.

52. The apparatus of claim 51, wherein said programming instructions are further designed to enable the apparatus to

receive a second zooming specification comprising one or more additional ones of said polynary string constituting symbols;

exclude a second subset of said remaining ones of said first regions based at least in part on said received second zooming specification; and

repeat said displaying for the remaining ones of said first regions.

53. The apparatus of claim 52, wherein said programming instructions are designed to enable the apparatus to

receive an unzoom specification;

restore the remaining ones of said first regions to re-include said excluded second subset of said first regions; and

repeat said displaying for the remaining ones of said first regions.

54. The apparatus of claim 51, wherein said programming instructions are further designed to enable the apparatus to

receive an unzoom specification;

restore the remaining ones of said first regions to re-include said excluded first subset of said first regions; and

repeat said displaying for said first regions.

55. The apparatus of claim 39, wherein said programming instructions are designed to enable the apparatus to perform said associating by associating, for each of said first regions, a selected one of a plurality of symbols with the region based at least in part on the determined graphing value of the region.

56. The apparatus of claim 39, wherein said programming instructions are designed to enable the apparatus to perform said associating by associating, for each of said first regions, a selected one of a plurality of color attributes with the region based at least in part on the determined graphing value of the region.

57. The apparatus of claim 39, wherein said programming instructions are designed to enable the apparatus to perform said associating by associating, for each of said first regions, a selected one of a plurality of colored geometric primitives with the region based at least in part on the determined graphing value of the region.

58. The apparatus of claim 39, wherein said programming instructions are designed to enable the apparatus to perform said associating by associating, for each of said first regions, a selected blending of a plurality of colors with the region based at least in part on contributions to the determined graphing value of the region.

59. The apparatus of claim 39, wherein said first regions correspond to all constituting regions of the first recursively partitioned/nested geometric structure, said first normalized multi-dimensional data are values of independent variables of a function, and said first graphing values are corresponding values of a dependent variable of the function.

60. The apparatus of claim 39, wherein said programming instructions are further designed to enable the apparatus to

identify a second plurality of regions within a second recursively partitioned/nested geometric structure that correspond to a second plurality of normalized multi-dimensional data of a second normalized multi-dimensional data space, the second recursively partitioned/nested geometric structure being corresponding to the second normalized multi-dimensional data space;

determine corresponding second graphing values for said second corresponding regions within said second recursively partitioned/nested geometric structure determined for said second normalized multi-dimensional data of said second normalized multi-dimensional data space;

associate corresponding second visual attributes with said second corresponding regions within said second recursively partitioned/nested geometric structure, based at least in part on corresponding ones of said determined second graphing values; and

display said second recursively partitioned/nested geometric structure, visually differentiating said second corresponding regions based at least in part on corresponding ones of said associated second visual attributes.

61. The apparatus of claim 60, wherein said first and second recursively partitioned/nested geometric structures are displayed in a manner such that both recursively partitioned/nested geometric structures are visible concurrently.

62. The apparatus of claim 61, wherein each of said first and second normalized multi-dimensional data of said first and second normalized multi-dimensional data spaces comprises a polynary string having a plurality of symbols, encoding a plurality of relative coordinate values, said programming instructions are further designed to enable the apparatus to

receive a first zooming specification comprising one or more of said polynary string constituting symbols;

exclude a first subset of said first regions based at least in part on said received first zooming specification;

exclude a second subset of said second regions based at least part on the removed ones of said first regions; and

repeat said displaying for the remaining ones of said first and second regions.

63. The apparatus of claim 60, wherein said first and second normalized multi-dimensional data are values of first and second input variables.

64. The apparatus of claim 60, wherein said first normalized multi-dimensional data are values of input variables, and said second normalized multi-dimensional data are values of corresponding output variables.

65. The apparatus of claim 39, wherein said apparatus is a selected one of a palm sized processor based device, a notebook computer, a desktop computer, a set-top box, a single processor server, a multi-processor server, and a collection of coupled servers.

66. The apparatus of claim 37, wherein said programming instructions are further designed to compute a location for a centroid for each of a plurality of primitive elements of the geometric structure.

67. The apparatus of claim 66, wherein said programming instructions are designed to compute coordinates (x_p, y_p) of the location of each centroid as follows:

$$Xp = Xc + R * \sum_{k=1}^{K} V(N,k) * C(N, m[Lk])$$
$$Yp = Yc + R * \sum_{k=1}^{K} V(N,k) * S(N, m[Lk])$$

where:

(X_c, Y_c) are coordinate values of the geometric structure's centroid;

R is a radius extending from the geometric structure's centroid to an outermost vertex of the geometric structure;

V(N, k) is w*(1 – w) **(k – 1) where w = 1/(1+sine(π/N));

$m[L_k]$ is outer vertex number (1, 2, …, N) assigned to the kth symbol appearing in a corresponding polynary string;

$C(N, m[L_k])$ = cosine(a* π); and

$S(N, m[L_k])$ = sine(a* π) [where a = $(5*N – 4*m[L_k])/(2*N)$].

68. The apparatus of claim 67, wherein said programming instructions are designed to compute the K values of V(N, k) once responsive to a specification of N.

69. The method of claim 67, wherein said programming instructions are designed to compute at least the N values of $C(N, m[L_k])$ or the N values of $S(N, m[L_k])$ once responsive to a specification of N.

70. An apparatus comprising

storage medium having stored therein programming instructions designed to enable the apparatus to

associate n symbolic representations with said n relative coordinate values, and

select the symbolic representation corresponding to the highest relative coordinate value as the first constituting member of the polynary string representation; and

at least one processor coupled to the storage medium to execute the programming instructions.

71. The apparatus of claim 70, wherein the programming instructions further enable the apparatus to

compute a constant value (F) by dividing (n – 1) by n; and

compute a variable value (G) by subtracting F from 1;

subtract G from the current highest relative coordinate value; and

select the symbolic representation corresponding to the current highest relative coordinate value as the next constituting member of the polynary string representation.

72. The apparatus of claim 71, wherein the programming instructions further enable the apparatus to

multiply the current value of G by F;

subtract G from the current highest relative coordinate value; and

select the symbolic representation corresponding to the current highest relative coordinate value as the next constituting member of the polynary string representation.

73. The apparatus of claim 72, wherein the programming instructions further enable the apparatus to repeat said multiply, subtracting and selecting operations set forth in claim 64.

74. The apparatus of claim 70, wherein said symbolic representation comprises a letter.

75. The apparatus of claim 70, wherein said symbolic representation comprises a special character.

76. The apparatus of claim 70, wherein said apparatus is a selected one of a palm sized processor based device, a notebook computer, a desktop computer, a set-top box, a single processor server, a multi-processor server, and a collection of coupled servers.

77. An apparatus comprising:

storage medium having stored therein a plurality of programming instructions designed to enable the apparatus to

determine appearance positions of appearance instances of symbolic members of a polynary string representation of an entity having a number of constituting variables, the symbolic members being corresponding to the constituting variables,

sum positional values corresponding to the appearance instances of the symbolic members in said polynary string representation, and

add the sum to an average residual relative coordinate value; and

at least one processor coupled to the storage medium to execute the programming instructions.

78. The apparatus of claim 77, wherein

each positional value equals to (1 – F) x F**(k – 1); and

the average residual relative coordinate value equals (1 – F) x F**K,

where F equals (n – 1)/n,

n equals the number of coordinate values,

k denotes a position in the polynary string representation; and

K denotes the length of the polynary string.

79. The apparatus of claim 77, wherein said apparatus is a selected one of a palm sized processor based device, a notebook computer, a desktop computer, a set-top box, a single processor server, a multi-processor server, and a collection of coupled servers.